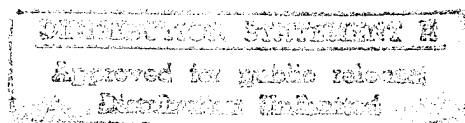


A Predictive Model of Navy Second-Term Retention

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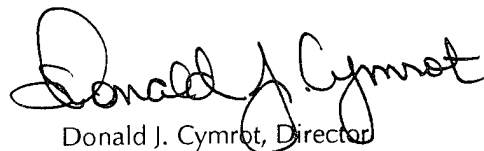
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Approved for distribution:

April 1996

A handwritten signature in black ink, reading "Donald J. Cymrot". The signature is fluid and cursive, with the first name "Donald" and last name "Cymrot" being more prominent than the middle initial "J".

Donald J. Cymrot, Director
Manpower, Personnel, and Training Team
Support Planning and Management Division

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Summary

Background

From FY 1992 to FY 1994, the Navy's Zone B retention rate for enlisted personnel fell by 13 percentage points. Zone B refers to sailors in their seventh to tenth year of service. The Center for Naval Analyses (CNA) studied this drop in retention and found that the FY 1994 rate was about 5 percentage points below the rate projected in the post-drawdown steady state [1]. The study also concluded that Navy drawdown policies could explain 8 percentage points of the 13-point decline in retention seen between FY 1992 and FY 1994. Of those 8 points, 2.5 were attributed to monetary separation incentives. However, the effects of any Navy policy are difficult to pinpoint because of the large number of factors at play that also affect retention. For example, the drawdown coincided with an upturn in the civilian economy, which may have also contributed to the drop in retention from FY 1992 to FY 1994.

In response, N1 tasked CNA to develop a predictive model that would

- Provide a general foundation for analysts to relate changes in Zone B retention to changes in Navy policy and in the career and personal characteristics of enlisted personnel
- Quantify the effect of drawdown programs on the recent drop in Zone B retention.

Approach

The Navy uses a number of tools to influence sailors' reenlistment decisions. For example, it offers the Selective Reenlistment Bonus (SRB) to induce sailors in targeted ratings to reenlist. During the drawdown, the Navy focused on reducing retention through early retirement, early out, and separation incentives, such as the Voluntary

Separation Incentive (VSI) or Special Separation Benefit (SSB). We focus our analysis on the VSI/SSB because it was the largest and most complex of the separation programs affecting Zone B retention.

Our retention model also includes other factors that drive sailors' stay/leave decisions, such as the following:

- The civilian unemployment rate
- Career characteristics (rating, paygrade, length of service, etc.)
- Family characteristics (marital status, number of children, single parenthood, marriage to another active-duty member of the military, etc.)
- Personal variables (age, education, race, gender, etc.).

We collected these data for sailors who made Zone B retention decisions between FY 1983 and FY 1994.¹ Using regression analysis, we estimate the impact of each of these variables on retention. Regression techniques allow us to isolate the effect of each factor, holding all others constant.

We estimate the impact of the VSI/SSB on retention by comparing retention rates of sailors who were eligible for the bonus and those who were not. Identifying the effect of eligibility on retention is complicated by the mutual dependence of eligibility and retention: it is likely that the Navy chooses particular groups for participation in the program on the basis of their retention probabilities. We experimented with a two-stage model that accounts for the simultaneous determination of retention rates and eligibility for the VSI/SSB.

The influence of such economic incentives as the VSI/SSB and the SRB on retention is of great interest because they represent policies that the Navy can directly control. Other policy changes may have indirect effects on Zone B retention. We use the model to predict effects of such a policy change on Zone B retention.

1. For a model of Zone A retention, see [2].

Conclusions

The model we estimated will allow Navy analysts to predict changes in Zone B retention due to changes in Navy policies and due to changes in sailors' average career histories and personal characteristics. Our most important result is the estimated model itself, which allows the Navy to isolate the effect on retention of a change in any one of a number of predictor variables, such as SRB eligibility and levels, VSI/SSB eligibility, the unemployment rate, and sailors' average career histories and personal characteristics.

Our VSI/SSB eligibility result is of particular interest for two reasons. First, the program appears to have driven some of the drop in second-term retention between FY 1992 and FY 1994. We found a positive, statistically significant relationship between VSI/SSB eligibility and the probability of leaving the Navy, all else equal. The effect of the VSI/SSB program was to reduce retention by 2.3 percentage points under what it would have been had the program not been in place. This is consistent with previous CNA work [1, 3], which argued that 2.5 points of the 13-percentage-point drop in retention between FY 1992 and FY 1994 could be explained by the VSI/SSB.

Second, our results suggest that two-stage analysis of VSI/SSB eligibility and stay/leave decisions was appropriate. We found statistically significant relationships between eligibility and excess inventory in a sailor's rating and paygrade. We took these relationships into account when we estimated the impact of eligibility on the probability of leaving the Navy. This approach may also be appropriate for future work on the retention impact of other incentive programs, such as the SRB.

Data and variables for the retention model

Data

Sailors make their second-term reenlistment or extension decisions at some point between their sixth and tenth years of service—that is, while they are in Zone B. Because enlistment contracts themselves are difficult to track over time, our analysis of second-term retention is based on sailors who were in Zone B at the time they made their decisions.

We drew our sample from CNA's Enlisted Tracking File (ETF) for FY 1983–1994. Most of the data we use in our retention model come from the detailed personal and career information available in the ETF. For other variables, we had to pull data from other sources; this section describes the supplemental sources for these variables.

More than 200,000 Zone B retention decisions were made between 1983 and 1994. Some sailors made multiple decisions (e.g., extension followed by reenlistment). To produce a data set of manageable size, we drew a random sample of 27,575 observations. After we discarded observations with missing or invalid data, we were left with a final sample of 26,503 decisions made between FY 1983 and FY 1994. Appendix A gives details of the sample construction.

The ETF contains detailed information about the nature of stay/leave decisions. Our sample includes two types of losses:

- Personnel who left the Navy within 12 months of the end of their active obligated service
- Personnel who left more than 12 months before the end of their active obligated service.

We treat both types of losses in the same way, as decisions to forgo reenlistment or extension.²

Variables

Separation bonus eligibility

Because the VSI/SSB is a new policy (implemented in FY 1992–1994), it was an important focus of our analysis. How many sailors left because of the VSI/SSB? How much did the availability of the bonus reduce retention rates? Our model estimates the effect of the VSI/SSB on enlisted retention during the drawdown years.

We model the stay/leave decision as a function of a person's eligibility for the VSI/SSB. This approach conforms to those of other studies [4].

The Navy's VSI/SSB policy

The Navy offered the VSI/SSB to selected ratings in FY 1992–1994 as a means to hasten downsizing and to shape the force to future requirements. A sailor choosing the SSB upon declining reenlistment would receive a one-time, lump-sum payment, whereas those choosing the VSI would receive an annuity. In either case, the size of the bonus depended on years of service and base pay. The first enlisted offering was announced in January 1992. VSI/SSB losses date from June 1992 and continued through September 1994, the last month appearing in our data.

The Navy was committed to avoiding reductions in force (RIFs) and used the VSI/SSB to induce voluntary separations. The Navy's no-RIF policy distinguished it from the other services trying to draw down. For example, the Air Force, facing deeper cuts than the Navy, announced

2. The factors that drive personnel to leave more than a year before the end of their contracts may differ from those leading them to leave when their enlistment term ends. However, the classic "attrition" factors—drug use, inability to adapt to military life, chronic health problems—are less important in Zone B than in Zone A. In Zone B, a number of early losses arise from the decommissioning of ships and bases and from such policies as the VSI/SSB.

that RIFs would be used if the VSI/SSB proved insufficient. A recent study [5] found that Air Force personnel, who faced a greater probability of a RIF, were more likely to accept the separation bonus than were eligible Navy personnel.

The Navy limited its enlisted offerings to sailors in grade E-5 and above who had between 8 and 20 years of service. In Zone B, only about half of all decision-makers would have met these minimal criteria. Ratings, paygrades, and length-of-service groups eligible for the bonus were likely to be characterized by excess supply: inventory is high relative to projected requirements in the new, post-drawdown steady state.

Who qualified for the VSI/SSB?

Table 1 shows the percentage of personnel in Zone B who were eligible for the VSI/SSB in the fiscal year of decision. The first column shows the eligibility rate for our sample of FY 1992–1994 decision-makers.³ Sample Zone C qualification rates are shown for comparison. Zone C eligibility rates were higher than the Zone B rates because the offering targeted longer lengths of service and higher grades, so more Zone C decision-makers met the eligibility criteria. As the drawdown progressed, policy-makers started targeting less senior personnel, and Zone B eligibility rates increased in FY 1993 and FY 1994.

Table 1. VSI/SSB eligibility rates by fiscal year of decision

Fiscal year of decision	Zone B sample	Zone C sample
1992	7.4%	55.0%
1993	14.2%	24.9%
1994	14.8%	33.6%
Number	6,439	4,324

3. We drew approximately one-tenth of all Zone B and Zone C decisions made between FY 1983 and FY 1994. Appendix A provides details of our Zone B sample construction. In our sample, there were 2,258 Zone B decisions in FY 1992, 2,139 in FY 1993, and 2,092 in FY 1994. The sample means shown in table 1 differ from the population means by less than 1 percentage point in all years.

Sailors who qualified for the VSI/SSB in Zone B were in paygrades E-5 and E-6 only. None of the offerings targeted E-7s with fewer than 10 years of service, so that any E-7s who qualified were in Zone C. No E-4s were eligible.

VSI/SSB eligibility data

The FY 1992–1994 VSI/SSB offerings were laid out in a series of naval messages. We created a number of variables indicating if the decision-maker qualified for the VSI/SSB. In each case, we computer-coded the eligibility criteria laid out in the naval messages and then matched the result to our enlisted data sets. The major determinants of eligibility are:

- Date of stay/leave decision
- Rating
- Paygrade
- Years of service
- Naval Enlisted Classification (NEC).

To simplify coding, we assumed that any decision-maker with a nuclear NEC was not qualified, and that nonnuclear NECs were eligible if they met the broader timing, rating, years of service, and grade criteria. VSI/SSB eligibility is complex, and, although we have made every effort to determine eligibility properly, there remains some error. We discuss the quality of our eligibility variable in appendix B.

To fully capture the effects of the VSI/SSB on retention, we also used data on inventory and requirements in 170 rating-paygrade groups. Inventory data were developed from the ETF, and data for requirements were taken from CNA's billet file, which shows authorized end-strength in each rating-paygrade.

The Selective Reenlistment Bonus

The Navy has offered the Selective Reenlistment Bonus (SRB) for many years as a way to increase retention in qualified ratings and NECs. Qualified Navy personnel get the SRB if they either extend or reenlist for at least 3 years. The amount of the bonus depends on a

sailor's base pay, months of additional obligated service, and an award level multiple ranging from 0 to 6. The ratings the Navy values most highly have SRB multiples of 6. In our Zone B data set, the sample mean SRB multiple was 1.27. The Navy changes the multiples periodically to reflect changes in retention and requirements in given ratings; ratings may qualify for the SRB in some years but not in others.

Our retention models included the SRB multiples that sailors were eligible for during the month of decision. We obtained SRB data from Department of Defense tapes that show monthly SRB multiples for all enlisted personnel dating back to 1977.

The civilian unemployment rate

The effect of the civilian unemployment rate on enlisted retention is well understood. Because higher unemployment rates reduce the expected size of the civilian earnings stream, they are associated with higher retention. Therefore, it is an important control variable in our model.

We used the unemployment rate for 25- to 54-year-olds broken down by race (black, white, or other), Hispanic origin, sex, and calendar year of decision [6]. We present these unemployment rates in appendix C.

Career variables

We included the following career variables in our Zone B retention models:

- Paygrade at the time of the decision
- Length of service at the time of the decision
- Indicator for selection for promotion at the time of the decision
- Demotion
- Broad rating group
- Indicator for most recent duty on shore.

When making reenlistment decisions, sailors compare prospective civilian earnings with their military earnings. They also assess their career potential and forecast future prospects for advancement. Of course, the current state of a sailor's career is only an imperfect guide to either military or civilian prospects, particularly given the youth of our samples. The uncertainty is likely to have been more pronounced during the drawdown, when Navy advancement rates changed rapidly and perhaps unpredictably [4]. Nevertheless, the career variables appearing in our model are the best proxies for the expected relative benefit of reenlisting or extending.

Together, paygrade and length of service determine base pay: higher grades or lengths of service raise military pay relative to prospective civilian pay, and are associated with higher retention. Longer service lengths also bring personnel closer to the 20-year pension vesting point; previous studies have found that at later years of service, the pension begins to govern Zone B and C reenlistment decisions [7].

Furthermore, for given lengths of service, higher paygrades imply more rapid rates of past advancement. For a given paygrade and length of service, selection for advancement implies higher base pay in the near future and strong career prospects. Having ever been demoted is an inauspicious career signal, regardless of one's current paygrade.

Some rating groups retain at higher rates than others. The rating group variables capture occupational differences in special pays, sea-shore rotation, promotion opportunity, and specialized skill acquisition.

Finally, having one's most recent duty be on shore means that subsequent duty is likely to be at sea. We assume that personnel generally consider sea duty unpleasant, and this assumption is supported in previous work [3, 8]. Therefore, we predict that recent shore duty reduces the probability of extending or reenlisting.

Personal characteristics

We included the following personal variables in our analysis:

- Race (black, white or other) and ethnicity (Hispanic or not)
- Gender

- Age at the time of decision
- High school degree and AFQT score
- Family variables
 - Marital status at the time of decision
 - Married female
 - Number of children
 - Number of children if married
 - Spouse in the military.

Race, gender, and ethnicity variables capture sample differences in civilian job opportunities and discrimination (real or perceived) in the Navy and civilian worlds. Gender also reflects differences in expected long-term career attachment, limits on occupational choice in the Navy, and the consequences of pregnancy. These factors suggest that women are less likely to retain than men. However, it is also possible that, given the career constraints they face, women who reach the second-term reenlistment point are particularly committed to the Navy. Most studies have found that minorities and women reenlist at higher rates than do white men [5].

Education and measured aptitude are important determinants of who stays and who leaves. It is difficult, however, to predict the impact of a high school degree or high measured aptitude on the probability of reenlistment because bright people have good career prospects in the civilian sector as well as in the Navy.

To capture educational attainment, we included a variable indicating a high school degree. Personnel who have a GED instead of a degree were classified along with those who had not graduated from high school at any time. We used the score on the AFQT as a measure of general mental aptitude or ability.

Family variables play an important role in the reenlistment decision. Married personnel, or those with children, may be less likely to undertake disruptive career changes and be more likely to reenlist. On the other hand, family attachments make sea/shore rotations and frequent moves particularly arduous.

Married women are expected to be less likely to reenlist or extend than are single men, single women, or married men because they generally perform more work at home.

It is unclear how having a spouse in the military will affect retention: on one hand, having a military spouse may indicate or foster greater commitment to a military lifestyle. On the other hand, coordinating family time when both spouses must contend with disruptive sea-shore rotations may be difficult enough to encourage one of them to leave the Navy.

Fiscal year of decision

Dummy variables indicating the fiscal year of decision capture broad changes in Navy policy and changes in the civilian economy—such as the military civilian wage differential—which are not reflected in the unemployment rate.

Estimation method

To estimate the effects of economic, career, and personal variables on Zone B retention, we model the retention decision as a binary choice. Sailors either stay (reenlist or extend) or leave on or before the end of their contracts. Table 2 summarizes our dependent variable. Several techniques are available to estimate models of binary choice. We chose the probit technique. Most of the explanatory variables in our model are assumed to be fixed and independent of the retention decision. The exception is VSI/SSB eligibility. Below, we explain how we modeled the effect of the bonus on retention.

Table 2. Dependent variable in retention model

Outcome	Description
Leave	Leave at or before end of second term contract
Stay	Reenlist for third term or extend

What has been the effect of the VSI/SSB eligibility on Zone B retention decisions? This is a difficult question to answer because the Navy eligibility criteria reflect its expectations about who will decide to stay and who will decide to leave.

In particular, eligible decision-makers are in ratings, grades, and length of service categories in which current and projected inventories exceed requirements. Because current inventory is a function of the previous period's retention rate, sailors who are eligible for the bonus may belong to occupational categories that typically retain at high rates. In contrast, ineligible decision-makers may tend to be in groups that have low previous-period retention rates. As a result, standard approaches to estimating the effect of the VSI/SSB are likely to understate its impact.

Underlying the relationship between eligibility and retention is a simultaneous system of equations in which eligibility and retention are mutually determined:

- The probability of retaining is a function of eligibility.
- The probability of eligibility is a function of retention.

To see how retention relates to eligibility, we theorized that the Navy's decision to offer the bonus to a given rating-paygrade group depends on the difference between inventories (INV) and billet requirements (BIL). Specifically, we predict that the Navy offers the bonus in a given rating-paygrade combination during year t if:

$$\text{INV}(t) - \text{BIL}(t) > K \quad (1)$$

INV(t) and BIL(t) are end-of-fiscal-year inventories and requirements. K is the Navy's excess inventory goal for the end of period t . The Navy is constrained in its ability to draw down the force all at once, so K may be positive in any one period. In the long run, $K = 0$.

We assume that the Navy knows with certainty what the end-of-year BIL is. The Navy's forecast of next year's inventory in a given rating-paygrade group depends on current inventory, promotion into and out of the grade, and the fraction of that inventory expected to continue into the next period. Most of the sailors who continue will do so because they are still under contract. The others are at their reenlistment point, making stay/leave decisions.

The above equation can be rewritten for each rating-paygrade as:

$$\begin{aligned} &\text{INV0}(t-1) * \text{PG1}(t) + \text{INV1}(t-1) * (1 - \text{PG2}(t) - \text{E}(\text{A}(t))) \\ &+ \text{INV2}(t-1) * \text{E}(\text{R}(t)) - \text{RQT}(t) > K \end{aligned} \quad (2)$$

Here, INV0($t-1$) is the current inventory of sailors in the rating who are in the previous paygrade, and PG1 is the rate at which they will be promoted into the grade in question. We assume the Navy knows next period's promotion rates. INV1($t-1$) is the inventory of sailors in the rating-paygrade group who are still under contract at the end of the last period. The share that continues to the end of the present period depends on the expected attrition rate $\text{E}(\text{A}(t))$ and on the rate of

promotion into the next grade, PG2. The quantity $INV2(t - 1)$ is the inventory of sailors who were at the end of their contracts at the end of last period and are making reenlistment decisions, and $E(R(t))$ is the probability of retention. Expected attrition and reenlistment rates are assumed to change each year. The expected rates feed into the Navy's decision to offer the VSI/SSB, and, in turn, the extent of the VSI/SSB offering affects actual attrition and retention.

The mutual determination of eligibility and retention means that single-equation techniques to estimate the effect of the bonus will yield incorrect estimates. To address this problem, we take a standard approach of estimating a system of equations in stages. We develop and estimate a system of two equations that explicitly capture the way retention/attrition probabilities determine whether a person was offered the VSI/SSB.

Our first equation estimates the probability that a sailor will qualify for the VSI/SSB, given changes in inventory and billet requirements in his or her rating-paygrade and on previous period VSI/SSB eligibility. We include the latter because there may be some "habit formation" in the Navy's decisions to offer the bonus. Once the bonus is offered in a certain rating and paygrade, Navy planners may be reluctant to remove it if retention there has historically been high, even if current inventories are quickly approaching requirements. The equation can be described as:

$$Q(t) = f(INV(t - 1), INV(t), BIL(t), Q(t - 1), \text{other variables}) \quad (3)$$

We estimate equation 3 using sailors in grades E-5 or E-6 making decisions during FY 1992–1994. $Q(t)$ is equal to 1 if the person qualified for the bonus, and zero otherwise. The equation yields a predicted probability, $Q(t)^*$, of eligibility for each sailor in our sample. Those who made decisions before FY 1992 or who were in paygrades other than E-5 or E-6 have $Q(t)^* = 0$. Values for $Q^*(t)$ are entered into our final retention equation:

$$R(t) = g(Q(t)^*, \text{personal characteristics, career variables, other economic variables}) \quad (4)$$

Results

Descriptive statistics

VSI/SSB eligibility and retention

Table 3 gives a breakdown of retention patterns for FY 1992–1994 by VSI/SSB eligibility. Because sailors can potentially leave with the VSI/SSB at any point during their enlistment, we distinguish between two types of losses: those who come within 12 months of reaching the end of active obligated service (“Leave at EAOS”) and those who leave 13 or more months before the end of their contract (“Leave before EAOS”).

Table 3. Type of decision by VSI/SSB eligibility and fiscal year^a

FY of decision	Ineligible for VSI/SSB			Eligible for VSI/SSB		
	Leave at EAOS	Leave before EAOS	Stay	Leave at EAOS	Leave before EAOS	Stay
1992	30.7	5.5	63.7	20.3	6.7	72.8
1993	31.1	8.6	60.2	34.2	19.1	46.7
1994	39.6	9.2	51.2	33.4	22.5	44.0

a. N = 6,489. The “Leave at EAOS” category refers to losses taken within 12 months of the end of active obligated service. “Leave before EAOS” refers to losses taken 13 months or more before EAOS.

The averages shown in table 3 indicate that:

- In FY 1992, eligible decision-makers were *less* likely to leave than were those who were ineligible. In FY 1993 and FY 1994, however, the retention rate was 7 to 14 points lower among those who were eligible for the VSI/SSB.
- In FY 1993 and FY 1994, the biggest effect of eligibility was on the share of sailors who left more than 12 months before the end of their term. The rate of early losses among the eligible was more than twice that of the ineligible in those years.

The second point is consistent with results of other studies, which found that a major effect of the VSI/SSB was to accelerate losses that would have occurred anyway [4].

Early losses drive the negative association between eligibility and retention seen in FY 1993 and FY 1994.⁴ Eligible attrition rates are more than twice that of the ineligible rates in FY 1993 and FY 1994. Depending on the timing of their eligibility, sailors could have left at any point in their terms with the VSI/SSB. It is likely that sailors who had the opportunity to leave with the bonus, but instead continued to the end of their term, had generally intended to reenlist or to extend.

It is difficult to explain why FY 1992 decision-makers were more likely to stay if they were eligible for the VSI/SSB than if they were not eligible. This result contradicts those of other studies on the effect of the VSI/SSB in FY 1992 [4, 5]. However, our result persisted in many statistical tests and under alternative coding schemes for the eligibility variable. Because the amount of the VSI/SSB payment is a positive function of years of service, it is possible that many sailors decided to wait a year, betting that the Navy would continue to offer the bonus in their rating-paygrade in following years.

Other variables

Table 4 shows descriptive statistics for other key variables. We have omitted rating groups from this table. From FY 1983 to FY 1994, 57 percent of Zone B decision-makers reenlisted or extended their contracts. Leavers tend to be slightly younger than stayers, to be in lower paygrades, and to have fewer years of service. Leavers have higher AFQT scores on average than do stayers, but are less likely to have high school degrees. The model also contains a number of family variables, including an interaction term between the dummy variable "Married" and the variable "Number of children." Table 4 shows that 61 percent of leavers are married, compared to 59 percent of stayers. Among both single and married personnel, leavers tend to have fewer children than do stayers.

4. Net retention—which excludes attrition—is about 68 percent for eligible sailors and 63 percent for ineligible during FY 1992–1994.

Table 4. Sample means by Zone B decision for selected variables,
FY 1983–1994

Variable	Stayers	Leavers
Reenlist	.87	–
Extend	.13	–
Leave at end of term	–	.82
Leave at least 12 months before term end	–	.18
Female	.10	.10
Caucasian	.71	.79
African American	.16	.15
Hispanic	.04	.04
Other minority	.07	.03
Age	28.55	28.20
Married	.59	.61
Military spouse	.05	.05
Number of children	1.02	.73
Married, X number of children	.93	.65
Married female	.05	.06
AFQT	61.46	63.40
High school diploma graduate (HSDG)	.88	.85
Paygrade:		
E1 or E2	<.01	.06
E3	<.01	.06
E4	.11	.19
E5	.49	.43
E6	.41	.24
E7	.02	<.01
Selected for promotion	.08	.04
Months of service	98.90	93.38
Last duty on shore	.55	.70
VSI/SSB	.03	.02
SRB multiple	1.37	1.18
Fiscal year of decision:		
1983	.06	.06
1984	.07	.07
1985	.07	.08
1986	.08	.09
1987	.09	.09
1988	.10	.10
1989	.09	.09
1990	.10	.09

Table 4. Sample means by Zone B decision for selected variables, FY 1983–1994 (continued)

Variable	Stayers	Leavers
Fiscal year of decision (continued):		
1991	.10	.09
1992	.10	.07
1993	.08	.08
1994	.07	.09
Number of observations	15,207	11,296

Estimation results

VSI/SSB eligibility

Table 5 shows the results of estimating equation 3 relating VSI/SSB eligibility to inventory and requirements in a sailor's rating-paygrade. Our sample included only those personnel who made decisions in FY 1992 through FY 1994, and were in paygrade E-5 or E-6, because other Zone B decision-makers fell outside the broadest parameters of the policy. The Navy restricted VSI/SSB offerings to sailors with 8 to 15 years of service (YOS). For this reason, we assigned a value of 0 to the variable "YOSYR8" for decision-makers with fewer than 8 YOS. Otherwise, we used actual YOS.

We tried several specifications, and show the results of three of them. The results from Model 1 are consistent with the hypothesis that the Navy offered the separation bonus to rating-paygrades that have

- Relatively high lagged inventories
- Relatively low current billet requirements.

In addition, the probability that the Navy offered the VSI/SSB was higher if it were also offered the previous year.

Models 2 and 3 are based on the premise that it is the difference between inventories and billets, and the rate at which the rating-paygrade is drawing down, that determine eligibility. Model 2 shows that the probability that a person is eligible for the VSI/SSB is higher under certain circumstances:

- The greater the difference between last-period inventory and current-period billets (INVMBI)—that is, the more overmanned the rating-paygrade was.
- If past year inventories (DINV) decreased rapidly—probably because eligible sailors are more likely than ineligible sailors to see inventories in their rating-paygrade shrink.

Table 5. The probability of VSI/SSB eligibility: probit estimates

Variable name	Variable description	Coefficient (std. error)		
		Model 1	Model 2	Model 3
Intercept	-	-4.05** (.17)	-4.13** (.17)	-4.16** (.18)
INV(t - 1)	Inventory at end of last year	.0006** (.00001)	-	-
INV(t - 2)	Inventory at start of last year	.0007** (.0001)	-	-
BIL(t)	Billets projected at end of current year	-.0014** (.0001)	-	-
Q(t - 1)	Rating/paygrade eligible in previous period	1.04** (.06)	1.02** (.07)	.60** (.09)
E-5	Paygrade E-5	.054 (.057)	.027 (.057)	.08 (.05)
YOSYR8	Actual years of service if YOS \geq 8; 0 otherwise	.28** (.02)	.27** (.02)	.30** (.01)
INVMBIL	INV(t - 1) - BIL(t)	-	.0008** (.00008)	-.0001 (.0001)
DINV	INV(t - 2) - INV(t - 1)	-	.0007** (.0001)	.0003 (.0002)
PQIMB	INVMBIL*Q(t - 1)	-	-	.002** (.0002)
PQDINV	DINV*Q(t - 1)	-	-.0002 (.0002)	-.0003 (.0002)
Log likelihood		-1,276	-1,296	-1,259
N = 5,203				

** Statistically significant at the 5-percent level.

Model 3 interacts last-period eligibility with DINV and INVMBIL. It is possible that the Navy offers the VSI/SSB for consecutive years if the rating-paygrade has been slow to draw down or needed a lot of downsizing. The results indicate that the effects of overmanning on eligibility are amplified if the VSI/SSB was also offered the previous year (PQIMB).

All three models include controls for an individual's length of service and a dummy variable indicating an E-5 paygrade. Not surprisingly, the correlation between length of service and the probability of eligibility is positive in all three models. Even though it is not statistically significant, the positive coefficient on paygrade is what we predicted: holding length of service constant, E-5s are more likely than E-6s to be in rating groups with low promotion opportunities, and advancement potential is one of the criteria the Navy used when selecting eligible ratings [4].

We used the results in Model 3 to form our predicted eligibility variable, Q^* , because log likelihood tests indicate that, of each of the three models, it best fit the data.⁵

Retention

Table 6 presents coefficient estimates for the predictive retention equation, together with the sample means of the explanatory variables.⁶ Here, we discuss the qualitative results implied by the coefficient estimates:

-
5. All the models shown contain some degree of multicollinearity between paygrade and years of service; it is least severe in Model 3. Multicollinearity distorts estimated standard errors, making it difficult to infer statistical significance. However, multicollinearity does not bias coefficient estimates, so they are still useful for prediction.
 6. Four rating groups do not appear in our random sample: SEAL, EOD, Nuclear Engineering trainee, and Diver.

- As predicted, eligibility for the VSI/SSB has a positive effect on the probability of leaving.⁷
- All else equal, women are more likely to reenlist or extend than are men, but marital status is a statistically significant predictor of female reenlistment decisions. Married women are more likely to leave than are married men, whereas single women are more likely to stay than are single men.
- Personnel who have a spouse in the military are less likely to leave than are those with civilian spouses.
- Single parents are more likely to stay than are married parents. Regardless of marital status, the probability of leaving decreases with the number of children.
- African-Americans and Hispanics are less likely to retain than whites. The statistical insignificance of many of the race/ethnicity variables may be attributed to multicollinearity with the unemployment rate variable.
- Sailors in higher paygrades are more likely to retain, as are those who are older and who have longer lengths of service. Evidence of demotion is strongly positively correlated with leaving, as is having the last duty be on shore.
- Personnel with high school degrees are less likely to leave than are those without them; however, the estimate is not statistically significant (p value = .30). Higher AFQT scores were significantly associated with a greater probability of leaving.

7. The results shown in table 6 use the predicted probabilities from equation 3, Model 3, as an instrument for VSI/SSB eligibility. When the eligibility variable is entered directly, the coefficient estimate falls from .68 to .42. This suggests that our two-stage model has, in fact, addressed potential simultaneity.

Table 6. The probability of leaving: probit estimates^a

Variable	Mean value	Coefficient	Std. error
Intercept		.30*	.16
Personal characteristics:			
Female	.10	-.16**	.04
Age at time of decision	28.58	-.01*	.003
African-American	.16	.08	.13
API and Other	.05	-.31**	.05
Hispanic	.04	.11	.08
Married	.68	-.28**	.02
Married female	.05	.36**	.04
Number of children	.89	-.13**	.03
Married, X number of children	.81	.09**	.03
Spouse in military	.05	-.10*	.04
High school degree	.87	-.02	.03
AFQT	61.21	.01**	.001
Pay and career variables:			
Years of service	8.08	-.08**	.01
Demoted from E4 or higher	.06	.84**	.06
Last duty on shore	.61	.42**	.02
Qualified for VSI/SSB-IV	.01	.68**	.10
SRB multiple	1.27	-.06**	.01
E1 or E2	.03	3.12**	.29
E3	.03	1.77**	.10
E4	.12	1.07**	.03
E5	.46	.42**	.02
E7	.01	-.53**	.09
Economic variable:			
Civilian unemployment rate	5.98	-.07**	.02
Rating group:			
Cryptology	.03	-.24**	.07
Surface combat systems	.07	.19**	.06
Surface operations	.10	.15**	.05
Surface engineering	.09	.11*	.05
Musician	.002		.21
Gendet	.001	.31	.29
Nuclear engineer—submarine	.04	.69**	.07
Nuclear engineer—surface	.02	.81**	.08
Aircrew	.02	-.55**	.09
CB	.02	-.24**	.07

Table 6. The probability of leaving: probit estimates^a (continued)

Variable	Mean value	Coefficient	Std. error
Hull, maintenance, electrical	.07	.01	.05
Aviation maintenance	.12	-.23**	.05
FCAEGIS	.002	.58**	.22
Aviation operations	.05	-.22**	.06
Aviation support	.03	-.41**	.07
Administration	.08	-.31**	.06
Deck	.05	-.17**	.06
Supply	.08	-.23**	.05
Medical	.06	-.25**	.05
Fiscal year of decision:			
1983	.06	.32**	.07
1984	.07	.08*	.05
1986	.08	.01	.04
1987	.09	-.06	.05
1988	.09	-.04	.05
1989	.09	-.07	.06
1990	.09	-.10**	.05
1991	.09	.02	.04
1992	.08	-.12*	.05
1993	.08	-.10**	.04
1994	.08	.01	.05

a. N = 26,503, LLF = -14,570.

Concordant observations: 80.3 percent.

Notes: Omitted paygrade is E-6, omitted race is Caucasian, omitted rating group is submarine, and omitted fiscal year is 1985.

**Statistically significant at the 1-percent level.

*Statistically significant at the 10-percent level.

In the following subsection, we describe some of the numerical predictions that the model yields.

Policy questions and marginal effects

Coefficients estimated using the probit technique are difficult to interpret: they do not by themselves tell us how a unit increase in an explanatory variable translates into a change in retention rates—the marginal effect. Here, we compute the marginal effects of selected variables on retention rates.

VSI/SSB eligibility

To compute the marginal effect of the VSI/SSB program on retention, we compare two scenarios: one in which everyone in the sample was eligible for the bonus, and one in which no one was eligible.⁸ The difference gives the marginal effect of program eligibility on retention rates.

Table 7 shows the impact of the VSI/SSB program on the probability of leaving the Navy. Because the program was in effect for FY 1992 through FY 1994, we computed the probabilities using sailors who made decisions during those years only. Among this subsample of 6,849, about 10 percent were eligible for the VSI/SSB. This baseline eligibility yields a predicted loss rate of 41.9 percent. If, instead, everyone who made stay/leave decisions during those years qualified for the bonus, 62 percent would have left. Had no one been eligible (had the program never been in place), about 40 percent would have left. This implies that eligibility increased the probability that the average sailor would leave by about 22.4 percent ($.620 - .396$).⁹

What would FY 1992–1994 retention have been had the VSI/SSB program not been in place? To answer this question, we compare the baseline outcome to the hypothetical case in which no one was offered the bonus. This exercise implies that the program reduced retention by 2.3 points ($41.9 - 39.6$). This estimate is consistent with previous work [1], which found a 13-point drop in retention between FY 1992 and FY 1994, and used results from [4] to conclude that about 2.5 points of it could be explained by the VSI/SSB.

-
8. We take average sample values of the probability of leaving, where the probability of leaving is computed from the standard normal density function.
 9. The single equation estimate, in which the eligibility variable is introduced directly into the probit equation, predicts a weaker effect of the program. For example, having extended eligibility to everyone would have increased the loss rate to 54 percent, as opposed to the 62 percent predicted here.

Table 7. Marginal effect of the VSI/SSB

Assumption	Mean value of eligibility dummy	Predicted probability of leaving
Everyone eligible	1	.620
No one eligible	0	.396
Baseline	.10	.419

The Selective Reenlistment Bonus

The SRB is a policy tool that permits the Navy to influence retention decisions of targeted sailors. Here, we consider the effect of changes average in SRB multiples on Zone B retention. SRB multiples range from 0 to 6, and the sample mean SRB multiple is 1.127. We compute the effects of doubling the average multiple. Table 8 shows the results of this exercise.

Table 8. Marginal effects of the SRB

Assumption	Average multiple	Predicted probability of leaving
Double average multiple	2.254	.406
Baseline	1.127	.426

Doubling the SRB above its sample average, which amounts to increasing the average by about one level, reduces the probability of leaving by 2 percentage points below the baseline.

Our estimate of the SRB effect on retention may be biased because it does not account for potential simultaneity between retention and SRB levels (sailors with a low probability of leaving will be offered lower SRBs). The systems approach we used for the VSI/SSB may be used to estimate the impact of the SRB on retention as well. Nevertheless, our marginal effect is consistent with that found in [2], which predicted that increasing all SRBs by one level increased Zone A retention by 1.5 points above the baseline.

The civilian unemployment rate

The unemployment rate reflects sailors' job opportunities outside the Navy. We considered the effect of a 1-point decrease in the unemployment rate by subtracting one point from the actual unemployment rates faced by the sailors in the sample at the time they made their stay/leave decisions.

The results, shown in table 9, indicate that a reduction in the unemployment rate by 1 point increases the probability of leaving by 2.2 points (*increasing* the unemployment rate has the symmetric effect of reducing loss rate by 2.2 points). This effect is large and can explain a good share of the drop in retention seen between FY 1992 and FY 1994. During this period, the average sample unemployment rate fell by 1.5 points, from 7.15 to 5.66 percent. This implies that about 3 points of the 13-point drop in retention over this period were attributable to the drop in the unemployment rate.

Table 9. Marginal effect of the civilian unemployment rate

Assumption	Mean value of unemployment rate	Predicted probability of leaving
Rate falls by 1 point	4.96	.448
Baseline	5.96	.426

Armed Forces Qualification Test and high school degree

The Navy wants to recruit and retain the highest quality people that it can—specifically, high school degree holders in the upper mental group.¹⁰ Often, however, high-quality recruits are those most likely to leave the Navy.

Let's suppose the Navy expanded recruiting to include more of those who test in the upper mental group but are not high school diploma graduates (HSDGs). If the Navy implements this policy, it will have a

10. An AFQT score of at least 50 places a person in the upper mental group.

downstream impact on the composition of Zone B decision-makers and will influence second-term retention rates indirectly.¹¹

We first consider the effect of increasing the percentage of Zone B decision-makers who test in the upper mental group by 5 percentage points. Next, we compute the effects of reducing the share of degree holders by 5 percentage points. Finally, we consider the retention effect of pursuing both policies simultaneously.¹² Table 10 shows the results.

Table 10. Marginal effects of AFQT and high school degree

Assumption	Predicted probability of leaving
Raise share with AFQT > 50 by 5 points	.430
Decrease share with high school degree by 5 points	.427
Pursue both policies at once	.431
Baseline	.426

Either raising the share of decision-makers with high AFQTs by 5 points or decreasing the share of high school degree holders by 5 points—or pursuing both policies simultaneously—would have a negative, but negligible, effect on Zone B retention. In each case, the probability of leaving increases by less than 1 percentage point. Thus, if the Navy changes its mix of recruits, any retention effects will be felt in Zone A and not Zone B. However, these policy changes would be considered moderate; more ambitious changes would have larger effects.

11. Currently, 62 percent of recruits have high school degrees and AFQT scores of at least 50. Only 5 percent of recruits test in the upper mental group but have no high school degree. The latter group may be an untapped source of new recruits. Increasing the share of non-HSDGs will have different retention effects in Zone A than in Zone B. In Zone A, HSDGs have higher retention rates than do non-HSDGs. In Zone B, high school degree has a negative (but statistically insignificant) effect on retention.
12. About 95 percent of the Navy's current recruits have high school degrees, compared to 86 percent in the FY 1983–1994 sample. We use historical, not current, averages as our baseline.

Appendix A: Selecting the Zone B sample

We began with 284,459 records of Zone B decision-makers—that is, personnel with 73 to 120 months of service. The fiscal year of decision ranges from 1983 to 1994. To get the data set down to a manageable size, we randomly selected about one-tenth of the records, leaving us with 27,757 observations.

At this point, a number of observations with unlikely paygrades were still in the sample. Zone B decision-makers can be expected to range in grade from E-4 through E-6. An unusually fast tracker might achieve grade E-7 in Zone B. Our data set, however, contained a handful of E-1s, E-2s, E-8s, and E-9s.

We ultimately retained E-1s and E-2s in the sample because:

- Their presence in the sample could often be attributed to demotion.
- Discarding them worsened the fit of the model.

We also checked the consistency of the records on E-8s and E-9s by examining the dates of rank. We could find no evidence that observations reporting a paygrade of E-8 or E-9 had errors in their records. Nevertheless, we eliminated E-8s and E-9s from the sample because of their small numbers (only four) and because including them did not improve the reliability of our estimates.

Eliminating grades E-8 and E-9 and discarding observations with missing data in other fields left us with 26,503 Zone B decisions to include in our analysis.

Appendix B: Determining VSI/SSB eligibility

Eligibility criteria laid out in the naval messages are extremely complex, and factors other than decision date, grade, length of service, and rating can determine eligibility. For example, in FY 1994, the Navy for the first time offered the bonus to sailors leaving decommissioning ships and bases. Also, sailors who were ineligible for reenlistment for disciplinary or other reasons were unable to qualify for the VSI/SSB.

We checked the accuracy of our coding by comparing our eligibility variable, QUAL, with DOD loss codes. The loss codes indicate if a person left under the VSI/SSB program or for a variety of other reasons. The first VSI/SSB losses appear in June 1992, and we coded all losses taken before that date as QUAL=0 by default.

The results of the comparison are mixed. In our sample, less than 1 percent (7 of 2,336) of leavers with QUAL=0 left with the VSI/SSB. This suggests that our coding is very accurate. However, 36 percent (129 of 352) of leavers who had QUAL=1 did not leave with the VSI/SSB.

To estimate the impact of the coding error, we recoded QUAL to equal 0 for leavers whose records did not show the VSI/SSB loss code in 1994. This change made a large difference in mean retention and attrition rates, and, in general, qualified sailors retained at consistently higher rates under this alternative coding scheme. We ultimately decided to use our original coding. Recoding only those observations that left (that had visible loss codes) would introduce a systematic measurement error.

There are a number of valid explanations for the disparity between our coding and the loss code data:

- The Navy received too many applications for the bonus and had to ration it.

- Some sailors who planned to leave anyway might also have missed application deadlines; most of the offerings specified narrow time windows.
- Even if sailors were eligible, they were recorded as leaving for other reasons, such as injury.
- Loss codes could be inconsistent. Most of the disparity is explained by a few codes indicating reenlistment ineligibility for reasons other than disciplinary; people who took the bonus might fall into this category.

Appendix C. Unemployment rates

The figures in table 11 are from [6]. The unemployment rates given for Caucasians and African-Americans do not include Hispanics, which we broke out as a separate category.

Table 11. Civilian unemployment rates for 25- to 54-year-olds, by year, gender, race, and ethnicity

FY	Males				Females			
	Caucasian	African-American	Hispanic	Other	Caucasian	African-American	Hispanic	Other
1982	7.1	15.6	10.7	14.2	6.9	13.6	11.7	12.7
1983	7.4	15.9	11.1	9.2	6.6	14.5	11.8	8.2
1984	5.2	12.1	8.3	7.1	5.5	12.0	9.3	6.4
1985	4.9	11.6	8.3	7.3	5.4	11.5	9.4	6.6
1986	4.9	11.4	8.7	6.7	5.1	10.9	9.1	5.7
1987	4.5	9.9	7.3	5.8	4.3	10.3	7.2	4.8
1988	3.8	8.9	6.5	4.8	3.9	9.4	6.6	4.4
1989	3.5	8.9	5.9	4.1	3.7	9.0	7.5	4.5
1990	3.9	9.4	6.7	5.4	3.9	8.7	7.2	5.3
1991	5.4	10.4	8.8	6.1	4.7	9.7	8.4	5.3
1992	5.9	12.3	9.8	7.0	5.2	10.8	10.1	6.5
1993	5.3	10.8	8.9	7.1	5.0	9.7	9.4	6.8
1994	4.3	9.1	7.7	6.7	4.4	8.7	9.3	7.0

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